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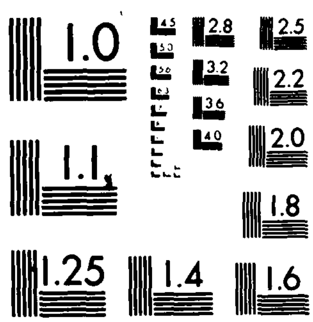

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US Army Corps
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The Hydrologic
Engineering Center

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HEC
Software Development
and Support

by

Bill S. Eichert

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HEC SOFTWARE DEVELOPMENT AND SUPPORT

Bill S. Eichert, Member, ASCE*

ABSTRACT: The Hydrologic Engineering Center (HEC) of the United States Army Corps of Engineers (Corps), serves the Corps in the area of hydrologic engineering and analytical planning techniques. The purpose is to assist Corps professionals in applying state-of-the-art technology to planning, design and operation problems in the water resources field. This is accomplished by developing new procedures and techniques (primarily computer programs), teaching use of the programs in formal training courses, developing and maintaining a library of state-of-the-art computer programs, and assisting Corps offices in applying the programs to current studies. This paper presents the HEC's goals and procedures necessary to develop and support the library of HEC computer programs. It also briefly overviews the 87 programs that are presently in the library.

INTRODUCTION TO HEC

The Hydrologic Engineering Center (HEC) of the United States Army Corps of Engineers (Corps) is located in Davis, California, and was established in 1964 to serve the 52 District and Division offices of the Corps in the area of hydrologic engineering. Its mission was expanded in 1971 to include responsibility for development and implementation of analytical planning techniques. The Center's basic purpose is to assist practicing engineers and planners throughout the Corps in applying state-of-the-art technology to planning, design and operation problems in the water resources field. This is accomplished by (1) locating, evaluating and/or developing new procedures and techniques (primarily computer programs), (2) teaching these and other state-of-the-art techniques in approximately 24 weeks of formal training courses each year, (3) developing and maintaining a comprehensive library of state-of-the-art computer programs for water resources planning and operation (see Table 1), and (4) assisting Corps offices in applying these techniques in current studies.

The Center's staff consists of approximately 40 employees, including 25 engineers, 5 computer system analysts and 10 technicians and clerical support personnel. An annual budget of about $2,500,000 includes $700,000 for reimbursable project studies, $400,000 for training, $200,000 for computer program (software) maintenance and $1,200,000 for research and development (includes developing and/or improving computer models).

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* Director, The Hydrologic Engineering Center, 609 Second Street, Suite D, Davis, California 95616 USA.

The HEC's areas of technical expertise are in hydrologic engineering, analytical techniques used in water resources planning, and related computer applications. They include the following areas:

- Precipitation-runoff processes
- Water resources systems
- Frequency and risk analysis
- Fluvial hydraulics
- Urban hydrology
- Water resources planning
- Real-time water control
- Hydropower
- Water supply

HEC GOALS IN SOFTWARE DEVELOPMENT

Since the missions of HEC are accomplished through the development and support of generalized software, this paper presents the HEC's goals and procedures necessary to develop and support this software.

The primary HEC goal in software development is to provide efficient tools that will be useful to a large number of people in performing important tasks in the planning, design and operation of water resource projects. The software developed must represent state-of-the-art technology and include most acceptable alternative computational methods, where appropriate.

The programs must be written in a generalized form so that all project related characteristics are provided to the program through input data so that the programs can be used on a large number of different water resources projects. The computer source code must also be written in a transportable style so it can be used on a variety of computer systems. Input and use of the programs must be simple and easy to understand to facilitate utilization of the software. The output from the programs must be clearly labeled and easy to understand. The programs must also be designed so that the user can have maximum control over the volume and type of output. The program code must be written in an easy to understand manner so that error corrections and program improvements can be made efficiently by persons other than the program authors. The programs must be rigorously tested and standard test sets developed and periodically executed to verify the accuracy of the code. The source code must be well documented by internal comment cards and a comprehensive programmers manual.

HEC COMPUTER PROGRAM SUPPORT PROCEDURES

The effective use of a computer program, which can be regarded as the ultimate payoff of the R&D effort to develop the model, is a direct function of the amount of support needed by the user and the amount of support available from the program author or organization. HEC's goal in supporting its computer programs is to provide sufficient documentation and training material to enable most individuals to apply the programs for most applications without additional help from HEC or other personnel. However, HEC does have staff members assigned to each major

computer program to provide needed advice and assistance to supplement the basic documentation. Advice and assistance on program use and error detection are normally provided over the telephone, but occasionally exchange of information by mail or in person is required.

Good documentation in the form of a "USERS MANUAL" that contains easy to understand examples (standard tests) and clearly written input instructions provides the needed interface between the program User and the HEC program.

In addition, HEC and others conduct training courses on computer programs and subjects related to the HEC computer programs to help introduce the programs and their uses to prospective users. Many of the course lectures have been video taped and are available to the general public along with workshop problems and training course manuals and other documents. Catalogs are available from HEC on computer programs, video tapes and publications. Many HEC training documents have also been written that explain concepts, philosophies and strategies for use of the computer programs.

Copies of current executable and source files are maintained by HEC on several computer systems for Corps offices. These same programs are often available through computer vendors for access by non-Corps offices. While the use of these HEC programs available on vendor systems is greatly encouraged, copies of HEC source decks and test data are also available on magnetic tape for use in implementing the programs on other computer systems. Personnel requesting copies of source decks through HEC are placed on a mailing list to periodically receive information on error corrections and improvements to the programs. Table 2 shows the current mailing list for the most popular HEC programs.

Because of the large number of computer programs available from HEC and the manpower and costs associated with full support to all computer models, HEC has developed three support levels (see figure 1) that describe the level of support that can be expected for a given computer program. A list of all of the HEC programs along with their support level is shown in Table 1. The amount of support required for each program is a direct function of the number of persons using the program and the size and complexity of the programs. Table 2 shows the approximate number of statements in the source code and the estimated number of Corps executions during fiscal year 1982 for the more popular HEC programs.

HEC SOFTWARE STANDARDS

HEC has prepared the draft of a publication entitled "Software Development Guidelines for Generalized Computer Programs". The general goals of these guidelines are to foster the development of improved computer software that will hopefully increase program reliability and to facilitate future modifications that occur during the development and maintenance phases of the program's life cycle. Specifically, the guidelines are intended to:

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- Simplify program design
- Enhance program readability
- Facilitate program modifications
- Decrease program maintenance costs
- Increase code transportability
- Create libraries of tested routines

The guidelines address the following ideas: (1) Development of Program Requirements, (2) Functional and Detailed Design, (3) Code Development, (4) Testing, (5) Documentation, (6) Program Maintenance, and (7) Review Procedures.

The basic ideas incorporated in the guidelines are as follows:

- Write statement of requirements.
- Design program using "top-down" design diagrams, showing important functional modules, and walk-through procedure before writing the code.
- Transform "top-down" design diagrams into diagrams, charts or pseudocode that enables direct and expedient conversion into computer code using small modules.
- Develop code using small single-purpose modular units which can be independently tested and easily understood.
- Develop new code using Fortran 77 standards. Discourage use of certain language features to allow a wider distribution to sites not currently supporting Fortran 77.
- Continue development of existing code using Fortran IV but conforming to guidelines as much as possible so that within a few years all existing, extensively used HEC programs will be compatible with all of the guidelines. The estimated Corps usage for fiscal year 1982 is shown in Table 2 for the most extensively used HEC programs.
- Develop all new code adhering to recommended programming conventions and standards spelled out in guidelines. Typical requirements relate to size of modules (250 statement maximum), single entry and exit points, error checks, common blocks, variable names, statement and sequence numbers, word length, internal documentation, input/output guidance, control structure, etc.

OVERVIEW OF HEC COMPUTER PROGRAMS

The majority of the 87 computer programs shown in Table 1 follow most of the HEC goals in software development mentioned previously in that they are state-of-the-art technology, generalized based on input, transportable, tested, etc. Exceptions to these general goals relate to the code being easy to understand and modify by others, and the code being well documented by internal comments and by programmers manuals. These later goals have not been accomplished to an acceptable level yet and are major reasons some of the programs are being modified to come into compliance with our computer program support procedures. Our goal is to get the most used HEC programs in conformance with our program guidelines over the next two or three years.

Technical areas covered by the HEC program shown in Table 1 include hydrologic engineering, analytical planning and data management.

Sixteen programs in the hydrologic analysis area involve rainfall/runoff analysis, flood routing and flood frequencies. Major programs in this category include HEC-1, STORM, and HECWRC. Six 1960 vintage programs (BASINC to BALHYD) are the original components for the HEC-1 rainfall/runoff model. These six programs are very small and would probably fit on current 16 bit microcomputers.

Fifteen programs fall into the Hydraulic Analysis area, which includes river hydraulics/fluvial hydraulics. The primary models are HEC's one-dimensional steady flow programs HEC-2 and the quasi-steady flow model HEC-6 plus the U.S. National Weather Service's DAMBRK and DWOPER. These later two programs are representative of routines that are developed by others and have such high value to the profession that HEC is willing to commit a limited amount of resources to foster their availability and use. Considerable Corps use has also been made of the two-dimensional RMA2 and RMA3 models developed by Resource Management Associates. HEC supports Corps applications of the DAMBRK model at support level 2, but provides only minimal support (level 3) for the other non HEC models.

Water Quality models are represented at HEC by five models. The main HEC models are the WQRRS and HEC5-Q. The other three models are small and should fit on 16 bit microcomputers.

Reservoir oriented models are represented by 10 programs. The primary models are HEC-5 which simulates the sequential operation of reservoir systems for flood control and conservation uses and HYDUR which analyzes hydropower using flow duration analysis. Five of the models (SWRFR through RESACT) are also 1960 vintage models which are small and should fit on 16 bit microcomputers.

Six of the 14 models listed under Planning Analysis represent HEC capability to do flood damage computations (using the EAD program) outside the two main simulation models already mentioned (HEC-1, HEC-5). The HEC-SAM system, which is a general purpose spatial data file focused procedure, is represented by the individual models RIA, HYDPAR, DAMCAL, ATODTA and SID. These models are used to connect grid cell data banks data with programs such as HEC-1, HEC-5, EAD, and STORM. Also used in the process are the seven Grid data programs (under Data Management).

Other data management models include four programs representing the HEC generalized Data Storage System (HECDSS). These four programs help HEC programs exchange data among themselves. For example, the DSPLAY program allows output from any HEC program which has DSS output capability to be plotted or tabulated conveniently.

The Real-Time Water Control programs are used to interface the HEC-1, HEC-5, and HECDSS programs to make real-time flood forecasts and to determine emergency reservoir release decisions for complex reservoir systems. These routines were made as system independent as possible, but still have some more advanced features which are dependent upon the computer system utilized. The Corps real-time applications are primarily based on the Harris 500 minicomputer.

FUTURE DIRECTION OF HEC SOFTWARE DEVELOPMENT

As indicated earlier, HEC is dedicated to improving the quality of its software in terms of software engineering concepts in order to make the code simpler, more readable, and easier to modify. These goals will be accomplished by applying the HEC program guidelines to all new or extensively used programs.

Historically, HEC software has been primarily oriented toward batch executions on large main frame computers. Recently HEC has used interactive programs for input data modifications, output displays, and job initiation. Because most HEC programs require large data handling and manipulation and/or large volumes of computations, HEC has not and may not use truly interactive programs extensively.

HEC software has not been developed for nor used on microcomputers in the past. This situation is changing now and will change more in the next few years as more microcomputers are available to field engineers, as smaller modules are developed to conform with HEC program standards, and as microcomputers get more powerful and versatile. HEC expects the 32 bit, virtual memory microcomputer developed over the next few years to be capable of executing most HEC programs without any difficulty. Therefore only modest efforts are planned to make current HEC programs available on the present 8 or 16 bit microcomputers. Over the next 12 months, six of HEC's smaller or medium sized programs are tentatively planned to be converted to these smaller microcomputers. These programs include HYCST, EDIT2, D2M2, EAD, HECWRC and UHCOMP.

HEC will continue to develop in the future, as it has in the past, the software tools required to assist in solving the dynamic problems encountered by the Corps field offices using the latest state-of-the-art technology and computer hardware and software concepts.

Figure 1

COMPUTER PROGRAM SUPPORT

The Hydrologic Engineering Center (HEC) maintains and distributes an extensive library of hydrologic and planning related FORTRAN computer programs. The library includes programs developed by HEC staff members, programs developed for the HEC or other Corps offices by contractors, and proprietary programs which have been acquired by the HEC for Corps use.

Programs have been categorized into three groups to indicate the level of support (documentation, error correction, code enhancement) available from the HEC; a description of each level of support is presented below.

Support Level 1 - is reserved for widely used, standard HEC programs, where significant experience exists in the application of such programs to current engineering problems. Source code enhancement/correction is ongoing and source code holders are periodically informed of changes.
(Distribution of source code for Level 1 programs is encouraged.)

Support Level 2 - is reserved for developmental, or moderately used, HEC or contractor programs where limited experience exists in the application of such programs to current engineering problems. Source code enhancement/correction is accomplished on a selected basis by HEC staff and/or contractor personnel. Documention enhancement/correction is performed as time and funds permit.
(Distribution of source code for Level 2 programs is made upon request, but user should be aware of developmental nature of some of these programs, and limited support for others.)

Support Level 3 - is reserved for little used, unsupported, inadequately documented, superseded or preliminary versions of HEC or contractor programs where little or no support is available to assist in the application of such programs to current engineering problems. Source code enhancement/correction is generally not performed.
(Distribution of source code for Level 3 programs is not encouraged, as HEC support is severely limited.)

Table 1

The Hydrologic Engineering Center

COMPUTER PROGRAMS SUPPORTED

Hydrologic Analysis		Support Level
HEC1	Flood Hydrograph Package	1
STØRM	Storage, Treatment, Overflow, Runoff Model	2
INTDRA	Interior Drainage Flood Routing	2
BASINC	Basin Rainfall and Snowmelt Computation	3
UHHC	Unit Graph and Hydrograph Computation	3
UHLRØ	Unit Graph and Loss Rate Optimization	3
HYDCR	Hydrograph Combining and Routing	3
SFRØ	Streamflow Routing Optimization	3
BALHYD	Balanced Hydrograph	3
FØRCST	Forecast River Flows by Regression	3
UHCOMP	Interactive Unit Hydrograph and Hydrograph Computation	3
HECWRC	Flood Flow Frequency Analysis	1
REGFQ	Regional Frequency Computation	3
HEC4	Monthly Streamflow Simulation	2
HMR52	Probable Maximum Storm (Eastern U.S.)	1
ØPRØUT	Streamflow Routing Optimization	3

Water Quality		
WQRRS	Water Quality for River-Reservoir Systems	2
RESTEMP	Reservoir Temperature Stratification	2
HEATX	Heat Exchange Program	3
THERMS	Thermal Simulation Program	3
HEC5Q	Simulation of Flood Control and Conservation Systems (including Water Quality Analysis)	3

Hydraulic Analysis		
HEC2	Water Surface Profiles	1
EDIT2	HEC2 Data Editor	2
HEC6	Scour and Deposition in Rivers and Reservoirs	1
USTFLØ	Gradually Varied Unsteady Flow Profiles	2
GEDA	Geometric Elements from Cross Section Coordinates	2
SHP	Stream Hydraulics Package	2
FEMFLØ	Finite Element Solution of Steady State Potential Flow Problems	3
HGP	Hydraulics Graphics Package	2
DAMBRK	NWS Dam Break Model	2
DWOPER	NWS Unsteady Flow Model (Dynamic Wave Operational)	3
RMA1	Finite Element Numerical Network Generator	3
RMA2	2-Dimensional Finite Element Hydrodynamics (Horizontal)	3
RMA4	2-Dimensional Finite Element Water Quality	3
RMA7	2-Dimensional Finite Element Hydrodynamics Vertical	3
USGS	USGS 2-D Groundwater Model	3

Reservoir Oriented Models		Support Level
HEC5	Simulation of Flood Control and Conservation Systems	1
HEC3	Reservoir System Analysis for Conservation	2
SWRFR	Spillway Rating and Flood Routing	3
SWRPTG	Spillway Rating - Partial Tainter Gate Openings	3
SWGRC	Spillway Gate Regulation Curve	3
RESYLD	Reservoir Yield	3
RESACT	Reservoir Area-Capacity Table by Conic Method	3
HYDUR	Hydropower Analysis Using Streamflow Duration Procedures	1
DISPLAY	Interactive Output Display for HEC5	2
INCARD	Flow Conversion Program for HEC5	2

Planning Analysis

RIA	Resource Information and Analysis Using Grid Cell Data Bank	1
HYDPAR	Hydrologic Parameters from Grid Data	1
DAMCAL	Damage Reach Stage - Damage Calculation - Grid Data	1
ATODTA	Automatic Parameter Transfer to HEC1	3
EAD	Expected Annual Flood Damage Computation	[illegible]
SID	Structure Inventory of Damages	1
INONSTR	Interactive Nonstructural Analysis Package	2
DEMAND	Water Demand Model	3
ADAPT	HEC - ADAPT - Triangular Terrain	3
HEP	Habit Evaluation Procedures	3
HYCST	Small Hydro Addition Cost Estimation	2
D2M2	Dredge Disposal Management Model	2
PBA	Project Benefit Analysis (Flood Damages)	3
SIDEDT	SID Edit - for SID Data	2

Miscellaneous Programs

REVISE	Free Format Data Entry and Revision	3
MLRP	Multiple Linear Regression	3
FSIR	Fortran Source Inventory and Renumbering	3
VERFIL	Text File Verification (CDC and Harris only)	3
HEC1CV	HEC1 Input Converter	3
COED	Corps' Text Editor (Harris computer only)	1

Data Management

HECDSS - Generalized Data Storage System for HEC Models

DSPLAY	Provides interactive tabulation, plotting, graphical input	1
DSSULT	Provides general data management functions for DSS	1
DSSMON	Controls multiple access to HECDSS files	1
D$SIN	Provides means of entering time series into DSS	1

Data Management (continued)		Support Level
Grid Data		
*GRIPS	Polygon to Grid Conversion Program	1
*AUTOMAPII	Line Printer Graphics for Polygon Data Program	1
FOURVIEW	Three Dimensional Pen Plot Program for Grid Data	2
*GRIDPLOT	Pen Plot of Grid Cell Data	2
*POLYPLOT	Pen Plot of Polygon Data	2
BANK	Data Bank Manager	2
REGISTER	Data Registration Program	2

Real-Time Water Control

ASYNC	Asynchronous Communication	1
CONVRT	Convert observed data to flows, storages, outflows, etc.	1
DATAST	Displays missing time series values	1
EXTRCT	Extracts subset of a Master Data Base	1
HEC1F	Modified version of HEC1 for real time forecasting	1
MODCON	Interactive control of various software models	1
PRECIP	Computes subbasin precipitation	1
PREFOR	HEC1F Input Editor	1
PREOP	HEC5 Input Editor	1
TSKRELAY	Message Relay Routine	1

*These programs have a proprietary status and are distributed and supplied by the Hydrologic Engineering Center to Corps offices only.

Table 2

HEC PROGRAM DISTRIBUTION AND UTILIZATION (CORPS ONLY)

Computer Program	Est. FY82 Monthly Corps Executions	Lines of Source Code	Present Mailing List Distribution: United States Gov	United States Univ	United States Pvt	Foreign	Totals
HEC-2	5,600	11,400	168	57	361	190	776
HEC-1	2,800	16,100	120	66	292	127	605
HEC-5	650	30,000	25	19	68	61	173
SAM (1)	470	13,810	26	2	9	26	63
HECWRC	270	1,600	18	5	33	23	79
EAD	190	2,400	11	2	9	12	34
WATER QUALITY (2)	150	21,000	24	9	48	46	127
HYDUR	145	7,400	6	2	17	13	38
MLRP	140	1,500	4	0	8	3	15
INTDRA	120	1,800	4	0	8	9	21
HEC-6	115	7,300	36	23	61	76	196
STORM	10	6,000	41	29	63	51	184
OTHERS (3)	1,611	70,000+	67	29	129	47	272
TOTAL	12,271	190,310	550	243	1,106	684	2,583
PERCENT			21	9	43	27	100

(1) Comprises 10 separate computer programs

(2) Comprises 12 separate computer programs not including HEC-50

(3) Comprises 28 separate computer programs

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

computers, computer programs, flood control, hydrology, hydrologic engineering, models, software, water resources

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Hydrologic Engineering Center (HEC) of the United States Army Corps of Engineers (Corps), serves the Corps in the area of hydrologic engineering and analytical planning techniques. The purpose is to assist Corps professionals in applying state-of-the-art technology to planning, design and operation problems in the water resources field. This is accomplished by developing new procedures and techniques (primarily computer programs), teaching use of the programs in formal training courses, developing and maintaining a library of state-of-the-art computer programs, and assisting Corps offices in (continued)

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TECHNICAL PAPERS (TP)

Technical papers are written by the staff of the HEC, sometimes in collaboration with persons from other organizations, for presentation at various conferences, meetings, seminars and other professional gatherings.

This listing includes publications starting in 1978.

HEC NUMBER	TITLE	HEC PRICE	NTIS NUMBER
		$2.00 Each	
TP 52	Potential Use of Digital Computer Ground Water Models, D. L. Gundlach, Apr 78, 38 pp.		ADA 106 251
TP-53	Development of Generalized Free Surface Flow Models Using Finite Element Techniques, D. M. Gee and R. C. MacArthur, Jul 78, 21 pp.		ADA 106 252
TP 54	Adjustment of Peak Discharge Rates for Urbanization, D. L. Gundlach, Sep 78, 7 pp		ADA 106 253
TP-55	The Development and Servicing of Spatial Data Management Techniques in the Corps of Engineers, R. P. Webb and D. W. Davis, Jul 78, 26 pp.		ADA 106 254
TP 56	Experiences of the Hydrologic Engineering Center in Maintaining Widely Used Hydrologic and Water Resource Computer Models, B. S. Eichert, Nov 78, 16 pp.		ADA 106 255
TP 57	Flood Damage Assessments Using Spatial Data Management Techniques, D. W. Davis and R. P. Webb, May 78, 27 pp.		ADA 106 256
TP-58	A Model for Evaluating Runoff Quality in Metropolitan Master Planning, L. A. Roesner, H. M. Nichandros, R. P. Shubinski, A. D. Feldman, J. W. Abbott, and A. O. Friedland, Apr 72, 81 pp.		ADA 106 257

TECHNICAL PAPERS (TP)(Continued)

HEC NUMBER	TITLE	HEC PRICE	NTIS NUMBER
		$2.00 Each	
TP-59	Testing of Several Runoff Models on an Urban Watershed, J. Abbott, Oct 78, 53 pp.		ADA 106 258
TP-60	Operational Simulation of a Reservoir System with Pumped Storage, G. F. McMahon, V. R. Bonner and B. S. Eichert, Feb 79, 32 pp.		ADA 106 259
TP-61	Technical Factors in Small Hydropower Planning, D. W. Davis, Feb 79, 35 pp.		ADA 109 757
TP-62	Flood Hydrograph and Peak Flow Frequency Analysis, A. D. Feldman, Mar 79 21 pp.		ADA 109 758
TP-63	HEC Contribution to Reservoir System Operation, B. S. Eichert and V. R. Bonner, Aug 79, 28 pp.		ADA-109 759
TP-64	Determining Peak-Discharge Frequencies in an Urbanizing Watershed: A Case Study, S. F. Daly and J. C. Peters, Jul 79, 15 pp.		ADA 109 760
TP-65	Feasibility Analysis in Small Hydropower Planning, D. W. Davis and B. W. Smith, Aug 79, 20 pp.		ADA 109 761
TP-66	Reservoir Storage Determination by Computer Simulation of Flood Control and Conservation Systems, B. S. Eichert, Oct 79, 10 pp.		ADA 109 762
TP-67	Hydrologic Land Use Classification Using LANDSAT, R. J. Cermak, A. D. Feldman and R. P. Webb, Oct 79, 26 pp.		ADA 109 763
TP-68	Interactive Nonstructural Flood-Control Plannng, D. T. Ford, Jun 80, 12 pp.		ADA 109 764

TECHNICAL PAPERS (TP)(Continued)

HEC NUMBER	TITLE	HEC PRICE	NTIS NUMBER
		$2.00 Each	
TP-69	Critical Water Surface by Minimum Specific Energy Using the Parabolic Method, B. S. Eichert, J 69, 15 pp.		ADA-951 599
TP-70	Corps of Engineers Experience with Automatic Calibration of a Precipitation-Runoff Model, D. T. Ford, E. C. Morris, and A. D. Feldman, May 80, 12 pp.		ADA-109 765
TP-71	Determination of Land Use from Satellite Imagery for Input to Hydrologic Models, R. P. Webb, R. Cermak, and A. D. Feldman, Apr 80, 18 pp.		ADA 109 766
TP-72	Application of the Finite Element Method to Vertically Stratified Hydrodynamic Flow and Water Quality, R. C. MacArthur and W. R. Norton, May 80, 12 pp.		ADA-109 767
TP-73	Flood Mitigation Planning Using HEC-SAM, D. W. Davis, Jun 80, 17 pp.		ADA-109 756
TP-74	Hydrographs by Single Linear Reservoir Model, J. T. Pederson, J. C. Peters, and O. J. Helweg, May 80, 17 pp.		ADA-109 768
TP-75	HEC Activities in Reservoir Analysis, V. R. Bonner, Jun 80, 10 pp.		ADA-109 769
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